

Polarization bidirectional reflectance factors for lidar calibration materials

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ABSTRACT

Physically derived five-parameter reflectance model is fit to polarization data acquired in the principal plane from reference materials used in optical remote sensing.

1. Introduction

Infrared lidar systems used in atmospheric remote sensing applications require that the backscatter signal be radiometrically calibrated. These systems are usually polarized and monostatic, and are calibrated using hard targets¹.

The reflected polarized radiance from the hard target depends on the surface, the diffuse, and the retroreflectance functions characterizing the material. In order to obtain well chosen functions for the modeling of the reflectance mechanisms of the material the model should be tested over a large range of experimental conditions². While the bidirectional reflectance distribution function, the BRDF, (directly related to the calibration parameter) has values on the hemisphere

covering the reflecting surface, an adequate sample of data would be its values in the principal plane which includes the surface normal and the incident beam. In order to supply a correlative calibration with other remote sensing techniques a physically derived model^{3,4,5} could be used to extend the angular range and to improve the angular resolution of the measured reflectance properties of the calibration materials.

2. Model

To meet the need for comprehensive reflectance modeling of the materials a modified version of the B. Hake and E. Wells model³ has been adapted and will be described.

$$BRDF(\theta_i, \phi_i : \theta_r, \phi_r) = A \left(\frac{1}{\mu + \mu_o} \right) [P(g, b, c) + RP(B, a, g)P(g, b, c) + H(\mu_o, \gamma)H(\mu, \gamma) - 1]$$

where : A = the amplitude factor, $w/4\pi$

$\mu = \cos \theta_r$ (reflected angle)

$\mu_o = \cos \theta_i$ (incident angle)

g = the phase angle, $g(\theta_i, \phi_i, \theta_r, \phi_r)$, the supplement to the scattering angle.

$P(g, b, c)$ = The phase function with parameters b and c

$RP(B, a, g)$ = The retroreflectance function with parameters B and a

$H(\mu_o, \gamma)$, $H(\mu, \gamma)$ = The Chandrasekhar H functions, where $\gamma = (1-w)^{1/2}$

w is the particle single scattering albedo.

Our objective is to apply this model to the polarization reflectance data taken in the principal plane for several wavelengths using a χ^2 parameter fitting algorithm to obtain a best fit set of parameters⁶.

Using this technique aids in the selection of the model functions employed to describe the prominent reflection processes characteristic of the experiment and the material

3. Preliminary Results

The polarization data modeled is from Spectralon², a pure sintered polytetrafluoroethylene (PTFE) material supplied by Labsphere Inc. Shown in Figure 1, are the BRDF for perpendicular polarization incident and perpendicular at the detector, SS and SP. This shows the high contrast of the polarized experimental data. The break in the experimental curves occurs at the incident angle.

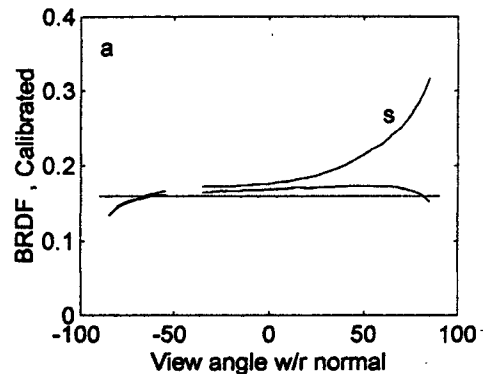
- (a) The SS curve is labeled S and the parallel at the detector SP curve is below. The straight line is at 0.159 the value of the ideal diffuse reflector.
- (b) The curve (oo) with the open segment at -45 ° is the experimental SS data, the total model is adjacent. The solid curve with negative curvature is the diffuse component. The + curve is the phase function. The retroreflectance function is minimized

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BRDF SS & SP DATA for ss44245.dat



BRDF FITTING FACTORS for splm07.txt

